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13. ABSTRACT ***(Maximum 200 Words)***

We recruited a cohort of over 600 active-duty military women attending the prenatal clinic at Wilbur Hall Medical Center and followed them until delivery to assess associations between stress, cardiovascular responsivity and risk of preterm delivery. In spite of universal access to prenatal care, rates of preterm delivery were more than twice as high among black women (14.0%) as among white women (6.4%), both overall and within each military rank. The Relative Risk (RR) of preterm delivery for black women, adjusted for relevant covariates, was 2.0 (95% Confidence Interval (CI) 0.9, 4.4). Of the job stressors we studied, including long hours, only a High Workload and Low Job Satisfaction had elevated relative risks for preterm delivery. The adjusted RRs for Workload and Job Satisfaction were 1.9, CI 0.8, 4.1 and 1.7, (CI 0.8, 3.9) respectively. However, neither job stressors nor perceived stress accounted for the black/white disparity in rates of prematurity.

Over 400 participants agreed to be tested for cardiovascular reactivity. Mean levels of blood pressure reactivity were higher among black women, and only the subgroup of black women showed adjusted gestational age differences associated with stress reactivity. Although, reactivity was not associated with spontaneous preterm delivery, there were too few cases to analyze separately by race.

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Addendum to the Final Report

September 31, 2001 marks the end of a 12-month no-cost extension granted by the Department of Defense for DAMD17-96-2-6019, "Cardiovascular Responsivity and Risk of Preterm Delivery."

Subject enrollment for this study was concluded on June 20, 2000. The no-cost extension period has been largely devoted to data analysis. Following is a brief recap of the study and a summary of the results.

Introduction

The disparity in rates of preterm delivery between African American and white women in the U.S. (1) is striking, virtually intractable and thus far inexplicable. Many of the obvious social and biological differences between African American and white women have been studied but seem to account for very little of the difference in rates of prematurity.

One recent research strategy has been to examine populations of African American and white women who are socially more homogeneous than the general population, e.g., women who are college graduates (2). We selected military women as the population for study; these women have ready access to uniform prenatal care, have a favorable BMI, and are physically fit. Our goal was to recruit a total of 1000 subjects. The similarities among women in the military would allow us to focus more sharply on a susceptibility factor we hypothesized might explain at least a portion of the racial disparity in rates of preterm delivery.

Specifically, we hypothesized that:

1. cardiovascular reactivity (as measured by altered heart rate and blood pressure responses to computer-driven stressful tasks) would be associated with gestational duration and preterm delivery, and

2. that African American women would have higher rates of reactivity, perhaps explaining in part the health disparity between prematurity rates in African American and white women.

Reactivity is defined as the propensity for an individual to undergo changes in cardiovascular activity during exposure to a stressor (3). Cardiovascular reactivity is presumed to be mediated by the neuroendocrine system. Conceivably, then, reactivity might be associated with preterm delivery either as a consequence of elevations in blood pressure or in stress hormones such as CRH (corticotropin-releasing hormone).

BODY

Overview of the Study Design

Subjects were recruited from the antenatal clinic of Wilbur Hall Medical Center, a large military hospital affiliated with Lackland Air Force Base in San Antonio, Texas. During the course of the study, the obstetric clinic at nearby Brooks Army Base merged with Wilbur Hall, so the actual subject population includes Army, Navy and Air Force personnel. Participants were interviewed at the time of enrollment early in pregnancy and were asked to return at 28 weeks of gestation to fill out a second questionnaire and complete the psychophysiological testing to determine cardiovascular reactivity.

The psychophysiological testing session consisted of two 5-minute computer-controlled laboratory stressors: a mental arithmetic task (serial 7 subtraction) and the Stroop color word task (naming the color of the ink used for the name of a color that may be printed in the same or different colored ink). Continuous blood pressure and heart rate responses were measured during a 5-minute base period and during the 5-minute recovery period following each task by means of a Finapres blood pressure cuff on the middle finger of the nondominant hand. Finapres readings are similar to readings obtained with a standard blood pressure cuff and the device is widely used in hospital settings.

The study questionnaires covered the following areas: sociodemographics; medical history; reproductive history, including a measure of infertility; pregnancy complications; lifestyle factors; hours worked; job characteristics; and subscales from the National Institute for Occupational Safety and Health (NIOSH) Job Stress Questionnaire (Role Conflict, Job Control, Job Satisfaction, Skill Utilization, Workload). Of particular interest in this group of women workers was length of the work week since women in the military may continue working up to the time of delivery. We also administered the Perceived Stress Scale (4), the General Health Questionnaire (5) and the Beck Depression Inventory (6).

Medical data on infections and the course and outcome of the pregnancy were abstracted from the hospital records. Gestational age was based on ultrasound or, in the few instances when ultrasound was unavailable, on the physician's assessment of gestation.

Participants

(Fig. 1) The target population for this study consisted of 1062 pregnant, active-duty military women attending the prenatal clinic at Wilbur Hall Medical Center (WHMC), Lackland Air Force Base, San Antonio, Texas. Of these, 338 (32%) were found to be ineligible. Some were ineligible for reasons such as multiple gestation or spontaneous abortion, but most of the ineligibility was due to either a planned change of station before the end of pregnancy; temporary duty at Lackland; or plans to leave the military altogether. Ineligibility due to military reasons peaked during 1999, at the time of the Bosnia conflict. Had it not been for the unexpectedly high rate of ineligibility, we would have come close to reaching our target sample size of 1000.

Among the 724 eligible women (1062 - 338), refusals were rare (n = 41), leaving a total of 683 participants. No outcome information was obtained on 75 participants who were considered lost to follow-up, leaving 608 as the sample for analysis. For three of these, no interview data are available.

Fig. 2 shows two defined subsets of the overall population that were also a focus for analysis.

Women with Spontaneous Deliveries

Strictly speaking only if a delivery occurs spontaneously can the real date of the event be known. For this reason, most studies of preterm birth are restricted to spontaneous deliveries; medically induced preterm deliveries are excluded or, depending upon the type of analysis, may be censored at the time of induction. In the case of very large samples, the medically indicated preterm deliveries may be analyzed as a separate group.

Excluding medically induced deliveries from our study population reduces the sample size considerably, from 608 to 472, and the number of preterm events decreases from n = 47 to n = 33.

In our sample, African American women are three times as likely as white women to have a medically indicated preterm delivery, usually related to preeclampsia. Another consequence of the focus on spontaneous deliveries, then, is that information is lost about this important aspect of the preterm problem.

Women Who Took the Stress Test

Although most participants returned for the 28 week questionnaire, only 64% agreed to undergo the psychophysiologic testing, which was to be part of the same appointment. Most women claimed not to have time to stay for the test, but efforts to reschedule another appointment were unsuccessful, suggesting there were reasons for refusing the test other than the time involved.

An analysis comparing women who took the stress test with those who did not take the test showed important differences. Those who elected not to take the test were more highly exposed to stressors and, as a group, they had a higher rate of preterm delivery than the test-takers (10.1% v. 6.6% respectively). This biased pattern of nonparticipation (selection for both the exposure and the outcome) has significant consequences. First, it means that the associations between stressors and preterm delivery observed in the "test-taker" sample are underestimates of the true association. Second, because of the loss of non-test-takers, we had insufficient power to explore any racial differential in cardiac reactivity as it might affect preterm delivery.

The sample size was further reduced for analyses of data from the reactivity tests when we restricted to spontaneous deliveries (N = 413 to N = 303).

Key Variables for Analysis

Stressors

The analysis focused on one self-reported work characteristic - hours worked per week, dichotomized as 40 hours per week or less versus more than 40 - and five measures based on NIOSH subscales assessing Workload, Job Control, Role Conflict, Skill Utilization and Job Satisfaction. Each of these was dichotomized as 'high' or 'low' based on a median split of the total sample. A more generalized measure of stress was derived from the Perceived Stress Scale (4), which includes such items as "In the last month, how often have you found you could not cope with all the things you had to do?" The Perceived Stress measure was similarly dichotomized as 'high' or 'low' based on the median score in the sample.

Reactivity

Cardiovascular reactivity was assessed using change scores. Measures calculated as the mean of the two task levels minus the baseline level were developed for heart rate (HR), systolic blood pressure (SBP) and diastolic blood pressure (DBP).

Statistical Methods

Rates of preterm delivery were calculated by delivery subtype and race. In addition, we estimated Kaplan-Meier survival curves by race for gestational age at delivery in weeks. The univariate association between study characteristics and spontaneous preterm delivery was assessed using the Pearson chi-square test. We also evaluated differences in study characteristics between African American and white women.

We used a Cox proportional hazards model to determine overall risk factors for preterm delivery in the population. The time variable used in the model was gestational age. Preterm delivery was defined as a spontaneous delivery prior to 37 completed weeks of gestation, or less than 259 days. Five women who were induced preterm after having spontaneous rupture of membranes were considered to have had spontaneous events. Women with induced deliveries were censored at the time of delivery. All other deliveries were censored at 37 completed weeks of gestation, since by our definition of preterm delivery they were no longer at risk. Covariates included in the final model were selected by a backwards procedure, in which a saturated model was evaluated and then covariates were removed one by one based on the Wald test. The resulting parameters as well as standard risk factors and demographic variables composed the base model from which risk ratios were estimated. Risk ratios for the remaining covariates were estimated by adding the covariate to the base model.

A second Cox model was constructed to examine what factors contributed to the difference in risk of preterm delivery between African American and white women. A slightly different selection process was utilized in order to evaluate what covariates influenced the African American:white risk ratio. The base model was composed of indicator variables for race in which white was the baseline. Potential confounders were added one by one and kept in the final model if they influenced the coefficient for African American women by 10% or more (7).

Differences in risk by rank were also explored further. Frequencies of job stress measures were calculated and tested for differences by rank using the Pearson chi-square test. Rates of preterm delivery by level of perceived stress and rank were also calculated. Differences in rank were also

examined multivariately in a Cox model using the same process as described above for the African American/ white analysis.

Due to sample size limitations, the timing of delivery was analyzed as both a continuous and dichotomous variable in the evaluation of stress reactivity. For the analysis of gestational age at delivery as a continuous outcome, we excluded women with induced deliveries (n=76). We examined associations between mean reactivity scores and gestational age according to demographic characteristics and other potential risk factors. Differences in means were evaluated by t-tests and ANOVA. Pearson correlation coefficients were calculated for reactivity change scores and gestational age.

We used multiple linear regression models to test the association of reactivity scores and gestational age at delivery while controlling for potential confounders. Covariates tested as potential confounders included race, previous preterm delivery, complications during pregnancy, education, marital status, maternal age, and any other study characteristic found to be associated with reactivity or gestational age. Covariates were kept in the final model if they influenced the coefficient for reactivity score by 10%. To test the hypothesis that African American women have higher rates of reactivity and thus, potentially, a larger effect on gestational age at delivery, we performed multiple linear regression analyses separately for African American and white women. A Cox proportional model using the same methodology as described above was used to examine the influence of reactivity change scores on the dichotomous outcome of preterm delivery.

In order to determine if high reactors with high exposure to stress had higher preterm delivery rates than low reactors, we examined univariately preterm delivery rates stratified by high or low reactors and high or low stress. A woman was considered a high SBP or DBP reactor if her reactivity score was above the median.

Results

Overall Risk Factors for Preterm Delivery

The rate for preterm delivery in the total sample was 7.7% (n=33). The rate for spontaneous preterm deliveries was 5.4%, for medically indicated deliveries 2.1%, and 0.2% for unknown type of labor (Table 1). In multivariate analysis, the only factors significantly related to a higher risk

of a spontaneous preterm delivery in the entire population were having had a previous preterm (RR=4.9) and having had intercourse for one year without pregnancy (RR=2.3) (Table 3). The risk for African American women was also elevated (RR=2.0, p=0.09). Having had at least one previous live birth (RR=0.3) and a high level of perceived stress (RR=0.4) were associated with reduced risk of preterm delivery. In addition, there was a trend towards decreased risk with increasing hours per week of leisure time exercise.

Differences in Preterm Delivery Risk between African American and White Women

The rate for preterm delivery among African American women was more than double the rate in white women (14.0% vs. 6.4%). This disparity was also found among delivery subtypes – the rate for spontaneous preterm delivery was 8.1% for African Americans compared to 4.6% for whites, and the rate for medically indicated deliveries was 4.1% for African Americans compared to 1.4% for whites. There were also many differences in study characteristics between African Americans and whites (Table 2). African American women were more likely to be younger, to be single, have only a high school education, have a higher BMI, be in the Army, and have complications during their pregnancy. White women were more likely to smoke or drink coffee during their pregnancy, work more than 40 hours per week, and to be officers. African American women were more likely to experience stressful conditions at work; they reported less job control and less job satisfaction. They also reported higher perceived stress. White women, on the other hand, had higher quantitative workloads.

The unadjusted R.R. for African American women compared to white women was 1.9 (p=0.08). In multivariate analyses, no covariates were found to alter the RR by 10% or more in this R.R., so the adjusted R.R. was essentially unchanged (RR=2.0).

Differences in Gestational Age at Delivery between African American and White Women

The Kaplan-Meier curves (Fig. 3) show that infants of African American mothers were delivered earlier than infants of white mothers (p = 0.008, Breslow test). The difference in percent delivered begins at 24 weeks, with the maximum difference occurring around 33 weeks of gestation.

Rank, Preterm Delivery, and Job Stress

The univariate preterm delivery rate was similar among officers and enlisted women (5.2% of the lower enlisted ranks, 5.9% of the higher enlisted ranks, and 5.3% of the officers). However, in

multivariate analyses using the lower enlisted ranks as the referent, officers appeared to be at the greatest risk (RR = 2.8, ns), with the higher enlisted ranks having close to the same increase (RR = 2.3, ns) (Table 3). The two covariates in the base model that accounted for much of the increase in the adjusted relative risks were parity and age.

On all measures of job stress except quantitative workload, officers were at an advantage compared to enlisted women, and the higher enlisted ranks were at an advantage compared to the lower enlisted ranks (Table 4). After adjustment for Job Satisfaction, the RR for officers to rose from 2.8 to 3.6.

There was some indication that low job satisfaction and high workload had a somewhat greater negative impact on preterm delivery rates in enlisted women than in officers (Table 5).

Reactivity and Gestational Age at Delivery

Sample characteristics by reactivity scores

African American women had significantly higher reactivity scores for SBP and DBP than white women. Officers, women with complications during pregnancy, and women who worked more than 40 hours per week also had significantly higher reactivity scores (Table 6). Older women and women with a history of infertility showed a tendency towards higher reactivity scores.

Sample characteristics, reactivity scores, and gestational age at delivery

African American women had a significantly earlier mean gestational age than white women (Table 6). There were no significant correlations between reactivity scores and gestational age at delivery in the overall population, although for systolic blood pressure reactivity (SR) and diastolic blood pressure reactivity (DR) the correlation coefficient, albeit small, was in the hypothesized direction (SR $r=-0.08$, DR $r=-0.03$) (Table 7). The correlation for heart rate reactivity (HR) and gestational at delivery was opposite the hypothesized direction, but was not significant.

African American women showed stronger correlations between all reactivity measures and gestational age compared to white women and to the total sample (which includes women of other ethnicities). Only for DR, however, did the coefficient approach statistical significance (DR $r=-0.22$, $p<0.10$).

In addition to the Pearson correlation analyses, we also carried out multivariate analyses (Table 8). In the subset of white women, the adjusted data showed no association between reactivity and gestational age. In African American women, however, there was a modest, significant association between DR and gestational age in weeks (b=-0.10, p=0.02).

Preterm Delivery among Women Who Took the Laboratory Stress Test

Among women who took the stress reactivity test, the rate for spontaneous preterm delivery was approximately the same for African American and white women (4.1% vs. 5.6%, 4.9% overall). The rate for medically indicated preterm deliveries, which were excluded from the analysis, was 1.6% overall, 4.1% for African American women, and 0.9% for white women.

Hazard rates produced by Cox proportional hazards models for SR, DR, and HR were not significant (Table 9). The number of events was too small to investigate interaction effects or racial subgroups.

Job stress measures did not appear to have a more deleterious effect on preterm delivery rates among high SBP or DBP reactors compared to low reactors (Table 10).

Gestational at Delivery among Women Who Took the Laboratory Stress Test

Kaplan-Meier curves (Fig. 4) show that among the test-takers, there is no significant difference by race.

DISCUSSION

A principal finding of this research is that in spite of a relatively low overall rate of preterm delivery (7.7%), the prematurity rates of white (6.4%) and African American (14.0%) active-duty military women from the same Air Force facility showed a more than twofold difference. This disparity exists despite a study design selected to increase homogeneity by race on social, biological and medical care dimensions. The difference in risk was unchanged by adjustment for reproductive factors, age, education, military rank, job stressors and perceived stress.

Theory has predicted that greater reactivity among African Americans, particularly in the vasculature, may underlie their increased risk for hypertension (8-9). The effect of race on stress reactivity has been examined mostly in males, with mixed results, although some of the inconsistencies may be explained by the fact that not all studies used the same laboratory stressors or recovery times. To our knowledge, this is only the second study to examine the role of cardiovascular reactivity in relation to the timing of delivery.

Like the small study of 40 primigravidas by Mc Cubbin et al. (10), we observed an association between higher reactivity and gestational age at delivery. In our study the association was restricted to the subgroup of African American women while the Mc Cubbin study found no interaction between reactivity and maternal race. Like the Mc Cubbin study, the association we observed was primarily with diastolic blood pressure ($\pi = -0.22$ vs. -0.36 in Mc Cubbin's sample) although systolic blood pressure showed a similar trend. Change in heart rate had no effect in either population. The difference in results might reflect differences in the two samples (Mc Cubbin's being of lower socioeconomic status) or in the testing protocols (Mc Cubbin used a single stressor and longer recovery periods).

Among African American women in our population the pretest blood pressure was also predictive of gestational age at delivery (data not shown). The relationship persisted among all deliveries after we excluded women with essential hypertension, pregnancy-induced hypertension or even a single elevated blood pressure. This association emerged despite the fact that a comparison of mean blood pressures between the subgroups of African American women and white women showed little difference.

Our results on reactivity are, of necessity, based on the approximately 64% of women who underwent psychophysiological testing. The non-test takers had greater exposure to sources of stress and a higher rate of preterm delivery. The bias introduced by this selection effect implies that the results we present are underestimates of the true effects. In addition, while it is possible that cardiovascular reactivity may explain part of the African American/white disparity in rates of prematurity, we were unable to pursue this because in the biased sample of women who underwent the psychophysiological testing that determined reactivity, the rates of prematurity did not vary by race.

Our findings related to military rank are also noteworthy. The strongest cardiovascular reactors we observed were officers, the majority of whom are white. In addition, the adjusted relative risk of spontaneous preterm delivery among officers was elevated (RR = 2.8). Although the elevated relative risk is not statistically significant, it deserves notice since it runs counter to the racial trend. Furthermore, high quantitative workload, which has a relative risk of 1.9 (ns) for preterm delivery, is almost twice as prevalent among officers (62.4%) than among those in the lower enlisted group (34.4%). When both workload and rank are in the model, the RR for officers decreases from 2.8 to 2.1. The role of work overload in the risk of prematurity among officers deserves further study, with a focus on measuring workload objectively as well as through self-appraisal.

In addition to Quantitative Workload, Low Job Satisfaction showed an elevated RR (1.7), also nonsignificant adjustment for job satisfaction raised the RR for officers from 2.8 to 3.6. None of the other workplace measures showed any association with preterm delivery.

One perplexing association warrants some discussion. We observed a greatly reduced risk of preterm delivery (RR = 0.4) among subjects who scored above the median on Cohen's 14 item Perceived Stress Scale. The rate of spontaneous preterm delivery among those with high Perceived Stress was 2.9% compared with a rate of 6.9% in those with low Perceived Stress. This counter-intuitive result is difficult to explain. The Cohen Scale is widely used and the items have face validity. However, it has been proposed that appraisal does not always reflect an individual's physiologic response to stress. Indeed, in our sample, mean reactivity levels do not differ significantly between women with high Perceived Stress and those with low Perceived Stress (data not shown) but, the general tendency is for those with low Perceived Stress to have higher levels.

CONCLUSIONS and RECOMMENDATIONS:

The rate of preterm birth in this population of military women is 7.7%, lower than the rate for the nation as a whole (11.2%), but higher than the average rate of 4% among other developed countries.

Features of the military environment may serve to reduce the risk of preterm delivery among pregnant women. These features might include universal access to prenatal care, standards for body weight and fitness, and screening for illicit drugs. More speculative possibilities include benefits derived from the social support and esprit de corps in the military. Future studies should explore various facets of membership in the military as possible determinants of reduced risk of prematurity.

Even within the relatively homogeneous environment of the military, African American women have twice the rate of preterm delivery as their white counterparts. This difference holds for both induced and spontaneous preterm deliveries.

These data imply that the attributes of the military population and environment that produce a lower rate of preterm delivery compared to the national average have little or no impact on the racial disparity. Since the difference in rates by race is present among both officers (African American: 9.1%, White: 5.4%) and enlisted personnel (lower enlisted African American 8.7%, White 4.3%) (higher enlisted African American 9.7%, White 5.1%), the social gradient represented by rank does not account for the disparity.

In multivariate analysis, the RR is 2.0 (95% CI 0.9, 4.0) for preterm delivery among African American women compared to whites in a model that includes biological risk factors as well as age and military rank, job stressors and perceived stress. These covariates had little effect since the unadjusted RR was 1.9. Adding variables measuring systolic and diastolic blood pressure to the model also had no influence on these results.

In previous studies, careful analysis has not successfully identified factor(s) responsible for the African American/white difference in rates of preterm delivery. Further study of military women could be designed to examine all aspects of the military experience that may be different for

African American and white personnel as well as biologic intermediates such as blood pressure reactivity. At a minimum, future studies should include measures of perceived racial and gender discrimination, both in and outside the workplace.

In multivariate models, African American women are stronger "reactors" than white women, and their reactivity (in DBP and to a lesser degree SBP) is associated with a reduction in gestational age at delivery. In the overall sample, no association was observed between stress reactivity and preterm delivery, but the number of events in the reactivity subset was too small to look at risk of preterm birth separately by race.

These results confirm part but not all of our hypotheses. The possibility that cardiovascular reactivity may play a role in the higher preterm delivery rates among African American women deserves further study in a larger population, taking steps to insure higher participation in the psychophysiological testing.

In addition to African American/white differences in prematurity, we also observed differences by rank, with officers and higher enlisted personnel having adjusted relative risks two to three-fold higher than the lower enlisted group.

These differences by rank can be explained mainly by the higher prevalence of standard risk factors for preterm delivery in the higher ranks (e.g., parity). Quantitative Workload, also more prevalent in the higher ranks, is also a potential risk factor. The higher reactivity among Officers is not an explanation since, overall, reactivity did not raise the risk for preterm delivery.

It should be noted that the elevated RR for Officers does not translate to a high rate of preterm delivery in the absolute sense, but it is higher than would be predicted by the many favorable circumstances, such as High Job Satisfaction, associated with this rank. Additional study aimed at investigating the hierarchy of ranks could potentially yield useful data about workplace and social risk factors for preterm delivery in military personnel.

In the subset of women with stress tests, there was no indication in the data that reactivity significantly modified the effect of stress on the risk of spontaneous preterm delivery.

Indeed some of the trends for low and high reactors were in the opposite direction from our hypothesis. It is possible that results for African American women might differ from those for the overall group but our numbers did not permit us to carry out subgroup analyses.

Significance of the Study Results

The most innovative aspect of this research was inclusion of psychophysiological testing of the participants, to distinguish those who were high cardiovascular reactors from those who were not and to investigate the possible role of reactivity in the occurrence of prematurity.

We found the highest level of reactivity among Officers and women working >40 hours per week during the second trimester of pregnancy. However, in our sample cardiovascular reactivity was not associated with preterm delivery. Furthermore, reactivity did not modify the effects of exposure to sources of stress on the rate of preterm delivery.

In the subgroup of African American women, however, reactivity was correlated with gestational age at delivery, and in multivariate analysis the mean gestational age in weeks was significantly earlier among African American women with higher DBP reactivity.

These data add to a small body of knowledge concerning cardiovascular reactivity and gestational age at delivery. They are the first data to address the role of cardiovascular reactivity in the African American/white disparity in preterm birth.

Our study also examined a number of work characteristics that might act as stressors during pregnancy. Long hours, which we had hypothesized could be associated with preterm delivery, did not show an adverse effect. Neither did Low Skill Utilization, Low Control or Role Conflict. We did observe (nonsignificant) increased risks related to a High Workload and to Low Job Satisfaction. In addition, we found an effect of rank: adjusted risks for preterm delivery were higher among officers and higher enlisted personnel than in the lower enlisted group (E1-E3). Within each rank category, the preterm rates for African American women were appreciably higher than for white women. These results concerning preterm delivery in the context of the military will be valuable in formulating new hypotheses to be tested in future studies of race, rank and the military workplace.

KEY RESEARCH ACCOMPLISHMENTS:

- Successfully enrolled a total of 608 active duty military women in the early stages of pregnancy. Achieved a participation rate among all eligible women of 95%.
- Administered a baseline questionnaire and a second questionnaire at approximately 28 weeks of gestation. Checked questionnaires at random for accuracy.
- Administered a computer-driven psychophysiologic test to 413 participants.
- All data were entered into the computer and range and logic checks were performed.
- Once the data were cleaned, statistical analyses were carried out. The results are summarized in this report, along with the investigators' interpretation of the findings.

REPORTABLE OUTCOMES:

- Preliminary data from this project were presented by the PI to the Department of Epidemiology, University of North Carolina, on May 2, 2001, as part of a presentation entitled Stress, Race and Preterm Delivery.
- Preparation of manuscripts based on the work described here is now underway.

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Figure 1. Study Recruitment

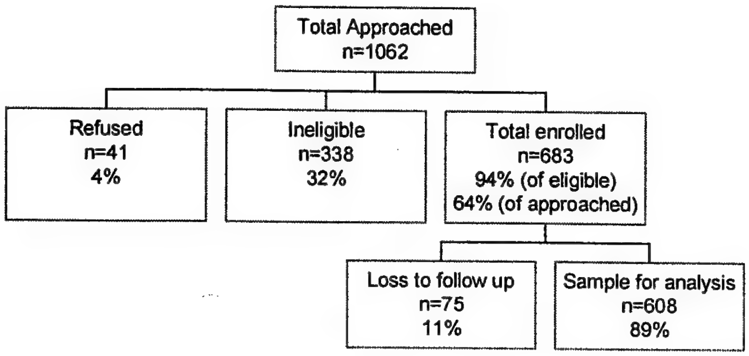

Figure 2. Subgroups for Analysis

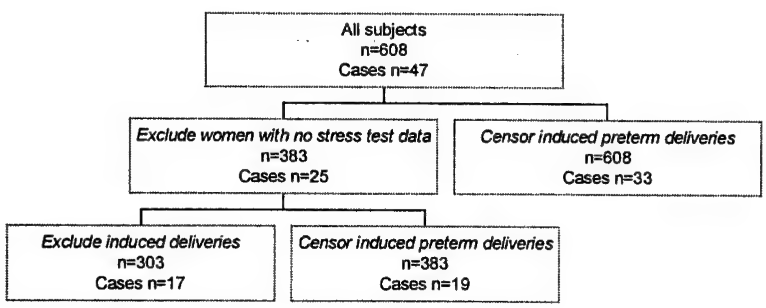

Figure 3. Kaplan-Meier Curves by Race

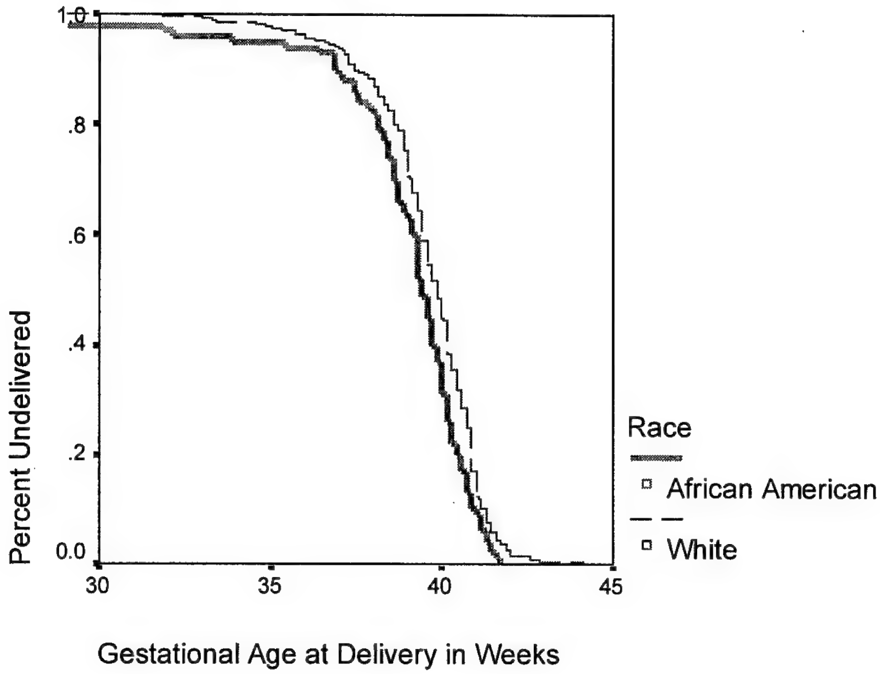

Figure 4. Kaplan-Meier Curves by Race

Women who took stress reactivity test

Table 1. Percent of deliveries occurring at less than 37 weeks in gestation.

Delivery type	All Women Total (n=608)	All Women White [¥] (n=362)	All Women African American (n=129)
All deliveries	7.7%	6.4%	14.0%
Spontaneous delivery [a]	5.4%	4.6%	8.1%
Medically indicated delivery [a]	2.1%	1.4%	4.1%

Delivery type	Women Who Took Stress Test Total (n=387)	Women Who Took Stress Test White [¥] (n=237)	Women Who Took Stress Test African American (n=75)
All deliveries	6.5%	6.3%	9.3%
Spontaneous delivery [a]	4.9%	5.6%	4.1%
Medically indicated delivery [a]	1.6%	0.9%	4.1%

[a] Data on type of labor missing on 23 subjects.
[¥] Women of other racial and ethnic groups not included in sub-group analyses due to insufficient data

Table 2. Sample characteristics by spontaneous preterm delivery and race.

Characteristic	Spontaneous Delivery <37 Weeks (n=594) [a]			Race [¥] (n=547)		
	Yes	No	p-value	African American	White	p-value
Age						
<20 yrs	12.1	5.2		10.5	4.2	
20-24	30.3	36.4		36.4	31.9	
25-29	39.4	33.3		31.5	35.4	
30+	18.2	25.1	p=0.26	21.7	28.5	p=0.02
Race						
White	54.6	60.4		--	--	
African American	36.4	19.8		--	--	
Asian	3.0	2.5		--	--	
Hispanic	6.1	11.4		--	--	
Other	0.0	5.9	p=0.13	--	--	
Years of education						
<=12	33.3	27.0		37.8	24.5	
13+	66.7	73.0	p=0.43	62.2	75.5	p<0.01
BMI						
<19.8	9.1	13.2		9.9	11.7	
19.8-26	84.9	74.1		72.3	78.1	
>26	6.1	12.8	p=0.36	17.7	10.2	p=0.06
Marital Status						
Married	24.2	22.8		62.9	81.4	
Not Married	75.8	77.7	p=0.79	37.1	18.6	p<0.01
Military branch						
Army	18.2	22.2		33.6	18.2	
Air Force	75.8	75.3		62.9	79.6	
Navy	6.1	2.5	p=0.43	3.5	2.2	p<0.01
Military rank						
E1-E3	24.2	26.3		35.0	21.0	
E4-E8	54.6	51.4		56.6	50.6	
O1-O5	21.2	22.3	p=0.94	8.4	28.4	p<0.01
Age at menarche						
≤11	15.6	16.0		20.0	15.4	
12-13	56.3	57.6		54.3	56.3	
14+	28.1	26.3	p=0.98	25.7	28.3	p=0.45

Table 2. (Contd.) Sample characteristics by spontaneous preterm delivery and African American or white race.

	Spontaneous Delivery <37 Weeks (n=594)[a]			Race[¥] (n=547)		
Characteristic	**Yes**	**No**	**p-value**	**African American**	**White**	**p-value**
Parity						
None	72.7	57.6		58.0	60.1	
1 or more	27.3	42.4	p=0.09	42.0	39.9	p=0.66
Previous preterm birth	15.2	5.9		8.4	5.9	
Yes	84.9	94.1	p=0.03	91.6	94.1	p=0.31
No						
Complications[†] during pregnancy						
Yes	21.2	28.2		23.8	29.5	
No	78.8	71.8	p=0.39	76.2	70.5	p=0.19
Intercourse for one year without pregnancy	31.3	15.0		15.5	16.4	
Yes	68.8	85.0	p=0.02	84.5	83.6	p=0.80
No						
Net weight gain per week in tertiles						
<0.31 kg/wk	40.6	32.6		35.2	31.4	
0.31-0.43	31.3	33.3		30.4	33.9	
>0.43	28.1	34.1	p=0.62	34.4	34.7	p=0.68
Smoked during pregnancy	3.0	6.2		2.1	7.2	
Yes	97.0	93.8	p=0.45	97.9	92.8	p=0.03
No						
Drank coffee during pregnancy						
Yes	24.2	29.4		18.9	30.7	
No	75.8	70.6	p=0.52	81.1	69.3	p<0.01
Drank alcohol during pregnancy						
Yes	3.7	3.3		1.7	4.4	
No	96.3	96.7	p=0.90	98.3	95.6	p=0.18
Hours worked per week						
<=40	53.9	46.4		68.1	49.2	
>40	46.2	53.6	p=0.98	31.9	50.8	p<0.01

Table 2. (Contd.) Sample characteristics by spontaneous preterm delivery and African American or white race.

Characteristic	Spontaneous Delivery <37 Weeks (n=594)[a]			Race[¥] (n=547)		
	Yes	No	p-value	African American	White	p-value
Hours exercised 2nd trimester[b]						
0	39.4	39.4		51.8	41.6	
1-3	42.4	29.2		21.7	28.9	
4-6	15.2	20.9		16.8	19.0	
>=7	3.0	10.5	p=0.26	9.8	10.5	p=0.16
Quantitative workload[b]	45.5	40.6		35.7	41.6	
High	54.6	59.4	p=0.59	64.3	58.4	p=0.21
Low						
Job control[b]						
High	42.4	45.3		32.9	45.8	
Low	57.6	54.7	p=0.75	67.1	54.2	p=0.01
Job satisfaction[b]						
High	30.3	49.7		33.6	48.3	
Low	69.7	50.3	p=0.03	66.4	51.7	p<0.01
Job skill utilization[b]						
High	69.7	63.1		65.7	66.3	
Low	30.3	36.9	p=0.45	34.3	33.7	p=0.90
Job role conflict[b]						
High	33.3	47.8		46.2	43.3	
Low	66.7	52.2	p=0.11	53.8	56.7	p=0.56
Perceived stress[b]						
High	24.2	47.4		49.7	40.1	
Low	75.8	52.6	p=0.01	50.4	59.9	p=0.05

[†] Complications include bleeding in 2nd or 3rd trimester, bacterial infections, gestational diabetes, asthma, vaginal herpes blisters, Rh blood problems, and hypertension during pregnancy

[a] Excludes 11 induced preterm deliveries and 3 women with no survey data

[b] Missing data for 73 women

[¥] Women of other racial and ethnic groups not included in sub-group analyses due to insufficient data

Table 3. Cox proportional hazards adjusted[†] risk ratios for preterm delivery, all subjects (n=605)[¥].

Characteristic	aRR	95% CI[¥]	Characteristic (*contd.*)	aRR	95% CI
Age			Net weight gain per week in tertiles		
<20 yrs	1.6	[0.4,6.3]	<0.31 kg/wk	1.5	[0.7,3.6]
20-24	1.0	ref	0.31-0.43	1.0	ref
25-29	1.3	[0.5,3.3]	>0.43	0.9	[0.4,2.3]
30+	0.9	[0.3,3.0]			
Race			Military branch		
White	1.0	ref	Army	1.0	ref
African American	2.0	[0.9,4.4]	Air Force	3.0	[0.5,17.0]
Other	0.6	[0.2,2.1]	Navy	1.3	[0.5,3.1]
Years of education			Military rank		
≤12	1.0	ref	E1-E3	1.0	ref
13+	1.0	[0.4,2.4]	E4-E8	2.3	[0.7,7.6]
			O1-O5	2.8	[0.6,12.1]
BMI			Hours exercised 2^{nd} trimester		
<19.8	0.4	[0.1,1.8]	0	1.0	ref
19.8-26	1.0	ref	1-3	1.9	[0.8,4.3]
>26	0.4	[0.1,1.6]	4-6	0.8	[0.3,2.6]
			≥7	0.4	[0.1,3.5]
Marital status			Hours worked per week[b]		
Married	1.5	[0.6,3.7]	≤40	1.0	ref
Not Married	1.0	ref	>40	1.3	[0.6,2.8]
Age at menarche			Quantitative workload[b]		
≤11	0.9	[0.4,2.4]	High	1.9	[0.8,4.1]
12-13	1.0	ref	Low	1.0	ref
14+	1.3	[0.6,3.0]			
Parity			Job control[b]		
None	1.0	ref	High	1.0	ref
1 or more	0.3	[0.1,1.0]	Low	0.8	[0.4,1.9]
Previous preterm birth			Job satisfaction[b]		
Yes	4.9	[1.2,19.3]	High	1.0	ref
No	1.0	ref	Low	1.7	[0.8,3.9]
Intercourse for year without pregnancy			Job skill utilization[b]		
Yes	2.3	[1.1,5.1]	High	1.0	ref
No	1.0	ref	Low	1.0	[0.4,2.2]

Table 3. (Contd.) Cox proportional hazards adjusted[†] risk ratios for preterm delivery, all subjects (n=605)[¥].

Characteristic	aRR	95% CI[¥]	Characteristic (*contd.*)	aRR	95% CI
Complications[a] during pregnancy			Job role conflict[b]		
Yes	1.4	[0.2,11.6]	High	0.8	[0.3,1.9]
No	1.0	ref	Low	1.0	ref
			Perceived stress[b]		
			High	0.4	[0.2,0.9]
			Low	1.0	ref

[†] Adjusted for previous preterm delivery, parity, infertility, age, race, and education.
[¥] No survey data for 3 women.
[¥] Confidence interval.
[a] Complications include bleeding in 2nd or 3rd trimester, bacterial infections, gestational diabetes, asthma, vaginal herpes blisters, Rh blood problems, and hypertension during pregnancy.
[b] Missing data for 19 women.

Table 4. Prevalence of stress measures, by rank (n=586)[a].

	Enlisted 1-Enlisted 3	Enlisted 4-Enlisted 8	Officers	
Perceived Stress				
High	59.1%	50.5%	43.2%	
Low	40.9%	49.5%	56.8%	p=0.03
Job Conflict				
High	49.4%	53.1%	48.8%	
Low	50.7%	46.9%	51.2%	p=0.63
Job Control				
High	41.6%	48.9%	60.0%	
Low	58.4%	51.1%	40.0%	p<0.01
Job Satisfaction				
High	43.5%	49.8%	70.4%	
Low	56.5%	50.2%	29.6%	p<001
Workload				
High	34.4%	42.7%	62.4%	
Low	65.6%	57.3%	37.6%	p<0.01
Skill Utilization				
High	53.9%	55.4%	84.0%	
Low	46.1%	44.6%	16.0%	p<0.01
Job Strain				
High	29.1%	27.3%	16.2%	
Low	71.0%	72.7%	83.8%	p=0.02

[a] Missing data for 19 women

Table 5. Measures of stress and percent of spontaneous preterm delivery, by rank (n=586)[¥].

	Overall	Enlisted 1-Enlisted 3	Enlisted 4-Enlisted 8	Officers
Perceived Stress				
High	2.9%	3.6%	2.8%	1.9%
Low	6.9%**	4.9%	7.1%*	8.5%
Job Conflict				
High	3.9%	4.2%	3.3%	5.0%
Low	5.5%	2.7%	6.8%	6.4%
Job Control				
High	5.1%	5.0%	5.1%	5.4%
Low	4.2%	2.4%	4.7%	6.1%
Job Satisfaction				
High	3.4%	1.6%	2.8%	5.8%
Low	6.1%	4.9%	7.1%	5.4%
Workload				
High	6.1%	6.3%	5.8%	6.6%
Low	3.6%	2.1%	4.3%	4.3%
Skill Utilization				
High	4.8%	5.3%	3.9%	5.8%
Low	4.6%	1.5%	6.1%	5.3%
Job Strain				
High	3.7%	2.0%	4.4%	4.8%
Low	6.1%	6.5%	6.3%	5.5%

*p<0.10
**p<0.05
[¥] Missing data for 19 women

Table 6. Sample characteristics by mean stress reactivity change scores and gestational age at delivery (n=303).

Characteristic	**Mean Increase in Heart Rate** (beats/min)	**Mean Increase in Systolic BP** (mmHg)	**Mean Increase in Diastolic BP** (mmHg)	**Gestational Age at Delivery** (weeks)
Age				
<20 yrs	1.9	5.8	4.1	39.7
20-24	3.1	6.3	3.8	39.7
25-29	3.3	7.0	3.6	39.4
30+	3.9	8.5	4.6	39.6
Race				
White	3.4	6.5	3.9	39.6
African American	3.1	8.8	4.3	39.5
Asian	2.9	7.5	3.4	39.8
Hispanic	3.0	8.1	4.3	39.5
Other	3.4	5.2	2.5	39.9
Years of education				
<=12	1.9	4.5	2.5	39.3
13+	3.0	6.3	3.5	39.3
BMI				
<19.8	4.2	7.7	4.6	39.5
19.8-26	3.2	7.1	3.9	39.5
>26	2.5	5.0	3.2	40.0
Marital Status				
Married	3.3	7.0	3.9	39.4
Not Married	3.1	7.3	4.0	39.2
Military branch				
Army	2.4	6.1	3.3	39.7
Air Force	3.5	7.4	4.1	39.5
Navy	5.9**	8.1	6.3	40.1
Military rank				
E1-E3	2.9	5.1	3.4	39.8
E4-E8	2.8	6.9	3.5	39.6
O1-O5	4.6**	9.7**	5.6**	39.3
Age at menarche				
≤11	3.4	6.2	3.5	39.2
12-13	3.4	7.5	4.1	39.7
14+	3.0	6.3	3.5	39.6

Table 6. (Contd.) Sample characteristics by mean stress reactivity change scores and gestational age at delivery (n=303).

Characteristic	**Mean Increase in Heart Rate** (beats/min)	**Mean Increase in Systolic BP** (mmHg)	**Mean Increase in Diastolic BP** (mmHg)	**Gestational Age at Delivery** (weeks)
Parity				
None	3.2	6.5	3.9	39.7
1 or more	3.4	7.8	3.9	39.4
Previous preterm birth				
Yes	3.9	5.5	3.1	38.1
No	3.2	7.2	4.0	39.7**
Complications† during pregnancy				
Yes	3.3	4.7	2.6	39.5
No	3.3	7.9	4.4	29.6
Intercourse for one year without pregnancy				
Yes	4.1	8.5	4.6	39.3
No	3.1	6.8	3.8	39.6
Net weight gain per week in tertiles				
<0.31 kg/wk	3.5	7.7	3.9	39.4
0.31-0.43	3.6	7.2	4.3	39.6
>0.43	2.6	6.4	3.7	39.7
Smoked during pregnancy				
Yes	2.2	3.2	4.0	39.5
No	3.3	7.3**	2.3	39.0
Drank coffee during pregnancy				
Yes	3.0	6.9	4.1	39.4
No	3.4	7.2	3.9	39.7
Drank alcohol during pregnancy				
Yes	3.1	7.3	3.2	39.4
No	3.3	7.0	4.0	39.6

Table 6. Sample characteristics by mean stress reactivity change scores and gestational age at delivery (n=303).

Characteristic	Mean Increase in Heart Rate (beats/min)	Mean Increase in Systolic BP (mmHg)	Mean Increase in Diastolic BP (mmHg)	Gestational Age at Delivery (weeks)
Hours worked per week				
<=40	3.1	5.8	3.3	39.6
>40	3.5	8.6**	4.6**	39.6
Hours exercised 2nd trimester				
0	3.1	7.1	4.9	39.5
1-3	3.6	6.7	3.7	39.5
4-6	3.0	6.9	4.5	39.5
>=7	3.4	8.2	4.0	40.0

† Complications include bleeding in 2nd or 3rd trimester, bacterial infections, gestational diabetes, asthma, vaginal herpes blisters, Rh blood problems, and hypertension during pregnancy
*p<0.10 for ANOVA test of difference of means between categories
**p<0.05 for ANOVA test of difference of means between categories
¥ Missing data for 19 women

Table 7. Pearson correlation coefficients for stress reactivity and gestational age at delivery, spontaneous deliveries only (n=303).

	Mean Increase: Systolic BP	Mean Increase: Diastolic BP	Mean Increase: Heartrate
Total (n=303)	-0.08	-0.03	0.03
White [¥] (n=186)	-0.08	0.003	0.05
African American (n=58)	-0.16	-0.22*	-0.08

* $p<0.10$
[¥] Women of other racial and ethnic groups not included in sub-group analyses due to insufficient data

Table 8. Adjusted gestational age differences in weeks associated with stress reactivity (n=303).

	All Subjects (n=303)		African American ¥ (n=187)		White (n=58)	
	ß	**p-value**	**ß**	**p-value**	**ß**	**p-value**
Mean Increase: Systolic BP	-0.02[a]	p=0.16	-0.04[b]	p=0.09	-0.02[c]	p=0.27
Mean Increase: Diastolic BP	-0.02[d]	p=0.47	-0.10[e]	p=0.02	-0.003[f]	p=0.91
Mean Increase: Heart Rate	-0.02[h]	p=0.37	-0.07[i]	p=0.32	0.03[j]	p=0.36

[a] Adjusted for previous preterm delivery, age, marital status, race, education, and complications
[b] Adjusted for previous preterm delivery, age, race, education, complications, and worked >40hrs/wk
[c] Adjusted for previous preterm delivery, age, race, education, and complications
[d] Adjusted for previous preterm delivery, age, race, education, complications and infertility
[e] Adjusted for previous preterm delivery, age, race, education, complications, and worked >40hrs/wk
[f] Adjusted for previous preterm delivery, age, race, education, complications, infertility and worked >40hrs/wk
[h] Adjusted for previous preterm delivery, age, race, education, complications, infertility, and pretest heart rate
[i] Adjusted for previous preterm delivery, age, race, education, complications, infertility, and worked >40hrs/wk
[j] Adjusted for previous preterm delivery, age, race, education, complications, and infertility

Table 9. Hazard ratios for stress reactivity and risk of spontaneous preterm delivery (n=383).

	All Subjects	
	aRR	**p-value**
Mean Increase: Systolic BP [a]	1.02	p=0.50
Mean Increase: Diastolic BP [b]	0.97	p=0.60
Mean Increase: Heart Rate [c]	1.60	p=0.41

[a] Adjusted for previous preterm delivery, age, race, education, complications, and parity
[b] Adjusted for previous preterm delivery, age, race, education, complications, parity, and infertility
[c] Adjusted for previous preterm delivery, age, race, education, complications, parity, and infertility

Table 10. Measures of stress and percent of spontaneous preterm delivery, by high and low systolic blood pressure and diastolic blood pressure reactors (n=383).

	Overall	SBP Low Reactors	SBP High Reactors	DBP Low Reactors	DBP High Reactors
Perceived Stress					
High	2.9%	2.9%	2.2%	3.6%	0.0%
Low	6.9%**	6.3%	9.4%	6.9%	7.7%*
Job Conflict					
High	3.9%	4.1%	2.2%	4.2%	2.0%
Low	5.5%	4.6%	9.4%	5.8%	6.3%
Job Control					
High	5.1%	4.1%	6.0%	4.1%	6.1%
Low	4.2%	4.5%	6.1%	6.0	2.0%
Job Satisfaction					
High	3.4%	4.6%	3.7%	4.5%	3.9%
Low	6.1%	3.9%	8.9%	5.6%	4.4%
Workload					
High	6.1%	7.0%	4.8%	7.2%	4.4%
Low	3.6%	2.0%**	7.0%	3.2%	3.8%
Skill Utilization					
High	4.8%	4.9%	4.4%	4.2%	6.3%
Low	4.6%	3.4%	9.7%	6.1%	0.0%
Job Strain					
High	3.7%	4.8%	3.7%	6.3%	0.0%
Low	6.1%	4.5%	6.9%	4.9%	5.9%

*p<0.10
**p<0.05